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DRAWINGS ATTACHED

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(54) IMPROVEMENTS IN CENTRIFUGAL GOVERNORS

(71) We, ROBERT BOSCH GmbH., a German Company, of Postfach 50, 7 Stuttgart 1, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a centrifugal variable speed governor for an internal combustion engine having an injection pump and a regulating rod on the injection pump for determining the injection quantity, i.e. the quantity of fuel injected per operating cycle of the engine, the governor comprising flyweights rotatable in synchronism with the injection pump and movements of which are adapted to vary the position of the regulating rod so as to reduce the injection quantity with increasing engine speed, a governor main spring which is selectively adjustable by means of a speed setting member and which is operative, by way of a lever system, to oppose the centrifugal forces on the flyweights and an idling spring for further opposing the centrifugal forces on the flyweights after the regulating rod has been moved a specific distance. Such a governor will hereinafter be referred to as a governor of the kind described.

In a known speed governor of the kind described (German Patent Specifications 1,011,223 and 1,080,814) the idling spring serves to provide a quite and steady idling speed and is always effective once the regulating rod has moved a specific distance regardless of whether the governor is set to govern at a low or a high speed. The idling spring always comes into effect at the same position of the regulating rod of the injection pump.

Thus, when the governor is set to govern at a high speed, and the internal combustion engine is under low load or no load, the idling spring will intervene to increase the maximum speed which the engine can reach before the injection quantity is reduced to zero. The harder the idling spring the greater will be this increase. This, however, is undesirable, especially in the case of governors used on three-phase generators, since their speed has to be kept constant within narrow limits in view of the effect on the frequency.

Beside the aforementioned applications the known arrangement of the idling spring has a particularly disadvantageous effect when the governor is used for a super-charged engine. In this case an increased full-load delivery is set on the injection pump by a special control device sensitive to the super-charge pressure, but independent of the speed which at the same time alters the range of the idling spring takes effect so that under no load operation the increase in maximum possible engine speed is even more significant.

Another governor of the kind described is known (German Patent Specification 958,704), where the effect of the idling spring is partly compensated for by a further spring which is ineffective when the engine is idling. The effect of the additional spring is not totally eliminated however. This limitation of the effect of the idling additional spring is not sufficient, however, especially in the case of the super-charged engine.

According to the present invention there is provided a governor of the kind described in which the said specific distance is dependent upon the position of the speed setting member.

When moved to a position corresponding to a higher governed engine speed, the speed setting member acts on the idling spring so as to increase the said specific distance.

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:—

Fig. 1 shows a longitudinal section through a governor of the invention taken along the line I—I in Fig. 2,

Fig. 2 is a section along the line II—II in Fig. 1,

Fig. 3 is a cross-section along the line III—III in Fig. 1, and

Fig. 4 is a graph showing the governing

characteristics of the governor of Figs. 1, 2 and 3 in accordance with the invention.

A plate 11 which carries flyweights 12 is fitted to the camshaft 10 of an injection pump for an internal combustion engine (not shown). The flyweights have arms 13 which acts upon the end face 14 of a thrust sleeve 15, which on its end facing the camshaft 10, has a radially inwardly directed flange 16 which is guided over a narrow annular region of a cylindrical shaft 17 extending out of the plate 11. The thrust sleeve 15 consists essentially of two parts, namely a tubular portion 15a on which the flange 16 is formed and a connection piece 15b connected to the tubular portion 15a by a roller bearing 18. The connection piece 15b comprises two pins 19 which engage into the lower end 20 of a guide lever 21, which is pivotally mounted on a pin 22 which is fixed in the governor housing 23 (see Fig. 2).

The guide lever 21 comprises two parallel arms which are connected to form a single lever by means of a spacer member 24 having a pair of trunnions 25. The lefthand trunnion 25 acts upon an intermediate lever 26 which has a forked end 26a projecting into a recess 27 in the governor housing 23 and is rotatable about a pin 29 which passes through this recess and a similar recess 28 arranged parallel to it. A connection rod 30 connects the upper end of the intermediate lever 26 to a regulating rod 31 which determines the quantity of fuel delivered by the injection pump during an operating cycle. The regulating rod 31, as indicated in Fig. 1 and as shown by dash-dotted line in Fig. 2, is situated to the left of the vertical central plane of the governor. In cases where the regulating rod 31, as indicated in Fig. 2 at 31a, is situated to the right of that plane, the intermediate lever 26 can be inserted with its forked end 26a into the recess 28 and can be coupled to the righthand end trunnion 25 of the spacer member 24.

In the governor housing 23 there is further mounted a rocking lever 32 which is pivotable about trunnions 33. One of the trunnions 33 has rigidly secured thereto a setting lever 34 lying outside the governor housing 23. A tensioning arm 35 on the locking lever 32 is attached the one end of a governor main spring 36 of which the other end is engaged in an eye 37 in a flange 38 formed on a reaction lever 39. The reaction lever 39 is mounted for pivotal movement about the same pin 22 as the guide lever 21 and serves to transmit the force exerted on the thrust sleeve by the flyweights onto the main spring 36 and vice versa.

The tensioning arm 35 is adjustably mounted on the rocking lever 32 and its position relative to the lever 32 may be adjusted by a screw 40 which enables fine adjustment of the stress of the governor main spring 36.

In the position of the rocking lever 32 shown in the drawings the spring 36 is extended by the maximum amount corresponding to the highest governing speed of the governor. The lower end of the reaction lever 39 rests against the head 41 of an adjustable stop-screw 42, which is screwed in a lug 43 of the governor housing 23 and which is locked in position by a lock nut 44. The reaction lever 39 has at its lower end a contact surface 45 which abuts a convex end face 46 of the thrust sleeve, when the latter is moved to the right (as viewed) by the centrifugal force on the flyweights.

The upper end of intermediate lever 26 engages one end of a starting spring 48, the other end of which is connected to a peg 49 fixed in the governor housing 23. The spring 48 acts as a play compensating spring and also determines the slope of the governor characteristic (as explained hereinafter) during starting, prior to the engine reaching its idling speed.

The lever 32 has a part 50 (see Figs. 2 and 3) to which there is secured a bolt 51. The bolt 51 is connected to one end 52 of a spring 53 the other end 54 of which is attached to one end of a two-armed lever 55. The lever 55 is pivotably mounted in a support block 56 screwed into the governor housing 23 and the end 57 of its other arm engages in a slot 58 in a piston (Figs. 1 and 3). The piston 59 forms a part of an idling stop device 60, which is screwed into the wall of the governor housing 23 and which further comprises an idling spring 61, an adjustable spring abutment bolt 62 which is locked in its preset positon by a locknut 63.

The spring 53 is stressed in the position of the rocking lever 32 shown in Fig. 3 and has acted on the lever 55 to move the piston 59 into the position shown in the drawing (Figs. 1 and 3), in which position the piston is moved out of the path of travel of the intermediate lever 26 and therefore never contacts the latter. When the setting lever 34 is moved from the position shown in the drawing, corresponding to the highest governed speed into a position corresponding to a lower speed, for example the position corresponding to the position 36' of the regulating spring shown in dash-dotted lines, or the position corresponding to the idling speed, the spring 53 is no longer under tension, thus allowing the lever 55 and the piston 59 to move into their positions shown in dash-dotted lines in Fig. 3. In this position, the piston 59 lies within the path of travel of the intermediate lever 26.

In Fig. 4 some of the regulating characteristics of the governor in accordance with the invention are shown. On the ordinate of the graph in Fig. 4, there is plotted the posi-

tion R of the regulating rod and on the abscissa the speed n of the engine. During starting of the internal combustion engine, with the governor main spring 36 fully stressed, the governing characteristic follows the curve A—B—C—D—E drawn in heavy lines. Up to the speed n^1 (from A to B) the rod 31 remains in the starting position R_s. On exceeding speed of n1 the thrust sleeve 15 moves against the force of the starting spring 48 a distance "a" (see Fig. 1) and reaches at speed n2 (point C) the full-load position Rv of the rod 31. The rod 31 retains this position in the present operating conditions up to point D and speed n4. Upon further increase of the speed (beyond speed n4) governing action commences to take place and in the extreme case speed n5 the rod 31 assumes the position Ro (point E) when no fuel is fed to the engine. When the setting lever 34 is in the idling position the governor characteristic follows the curves A—B—C—F—G also in heavy lines and when the lever 34 is set for governing at a speed between the idling speed nL and speed n4 the characteristic follows the curves H, J or K once the speed nL has been reached.

The break in the curve C—F—G at the point F is brought about by the intermediate lever abutting the piston 59 and thus bringing into effect the idling spring 61. When the idling spring is fixed, as in the case in prior art centrifugal governors, it is effective at all governed speeds when the regulating rod 31 is in a position below Rz (indicated by a thin broken line L) and it results in the maximum possible speed increasing from n5 to n6. However, owing to the elimination of the effect of the force of the idling spring 61 (See Figs. 1 and 3) provided by the present invention, the point at which the idling spring comes into effect occurs in the upper speed range from the point M along the dash-dotted line N, so that in the present governor an increase in speed beyond n5 is not possible.

This effect is particularly important when the governor is used for governing a supercharged engine and has a control device sensitive to the super-charge pressure (not shown) by means of which the full-load position Rv as well as the position Rz at which the idling spring has effect are raised to Rv1 and Rz1 respectively. In this case the governor characteristic at maximum position of the setting lever 34 would follow the line A—B—C—1—D1—E1 (heavy broken set of curves) and of the effect of the idling spring is not eliminated the highest speed n4 could reach the value n7.

Upon variation in the speed of the internal combustion engine the flyweights 12 alter their position and result in a displacement of the thrust sleeve 15 against the force of the governor main spring 36. The tubular portion 15a slides on the shaft 17, and the connection piece 15b acts on the guide lever 21 ot pivot the latter about the pin 22. When the speed of the internal combustion engine rises owing to diminishing load, the flyweights 12 move the thrust sleeve 15 to the right against the force of the governor main spring 36. The regulating rod 31 is then also moved towards the right and reduces the quantity of fuel delivered to the internal combustion engine until, at a higher speed, a new state of equilibrium is reached. Upon an increase in the load on the internal combustion engine the same reverse procedure takes place.

The method of operation of the governor will now be described further with reference to various operating conditions illustrated in Fig. 4.

In the position of the rocking lever 32 shown in the drawing, i.e. the maxiumm position of the setting lever 34, at standstill and in the region of the very low speeds n0—n1, which occur at the start of the internal combination engine, the flyweights 12 assume the position indicated on the drawing. The thrust sleeve 15, under the effect of the starting spring 48 acts by way of the guide lever 21 and the intermediary lever 26 on the regulating rod 31 to maintain the latter in a position (Rs), where the injection pump delivers a quantity of fuel to the internal combustion engine, which exceeds the full-load fuel delivery and facilitates the starting of the internal combustion engine. As soon as the internal combustion engine has started, however, the centrifugal force of the flyweights 12 overcome the force of the starting spring 48 and moves the thrust sleeve 15 a distance *a*, until it touches the contact surface 45 of the reaction lever 39. In this position of the thrust sleeve 15 the full-load fuel delivery is suplied to the internal combustion engine, corresponding to the position Rv of the regulating rod 31.

At a speed above the speed n4 the force on the flyweights also overcomes the force of the governor main spring 36 and moves the thrust sleeve 15 even further to the right. The guide lever 21 is pivoted together with the reaction lever 39 and the regulating rod 31 of the injection pump is moved via the intermediary lever 26 even more to the left (as viewed), until finally owing to the diminution of the fuel delivery to the internal combustion engine a new state of equilibrium is established and the speed of the internal combustion engine shows no further increase. In the extreme case the governor switches off the fuel delivery at n5 (Ro). In this operating state of the governor the intermediate lever 26 never contacts the piston 59, and the idling stop device 60 is never effective.

If the rocking lever 32 is brought into a

position, where the governor main spring 36 assumes a position 36′ shown in dash-dotted lines in Fig. 1, the flyweights 12 overcomes the forces due to the springs 36 and 48 at a lower speed, and governing thus takes place at lower speeds acording to curves H, J and K.

If the rocking lever 32 is moved still further in clockwise direction by means of the setting lever 34, for example into the idling speed (curve A—B—C—F—G), the flyweights 12 overcome the forces due to the springs 36 and 48 at the speed n2. The flyweights 12 move the thrust sleeve 15 to such an extent that the intermediate lever 26 when the regulating rod 31 is in position Rz, comes into contact with the piston 59 of the idling stop device 60. The spring 61 now serves to even out any fluctuations in the governor speed so as to achieve quite and steady idling. The length of the governor main spring 36 may be so chosen, that this spring 36 does not become effective at all in the idling range C—F—G. In this case the one end of this spring hangs loosely in the eye 37 and the springs 48 and 61 alone provide the forces opposing movement of the thrust sleeve (see C—F—G). The spring 48 additionally serves to compensate any play between thrust sleeve 15 and regulating rod 31.

By variation of the initial stress on the spring 61 by means of spring abutment bolt 62 or by substitution of a spring of different length and rigidity for the spring 61, and by substitution of the spring 53 the effective range of the idling stop 60 can be adapted in any desired manner to the required governing characteristic; i.e. the dash-dotted line N in Fig. 4 shifts to the left or right, or varies its slope.

WHAT WE CLAIM IS:—

1. A centrifugal variable speed governor for an internal combustion engine having an injection pump and a regulating rod on the injection pump for determining the injection quantity, the governor comprising flyweights rotatable in synchronism with the injection pump and movement of which is adapted to vary the position of the regulating rod in a sense to reduce the injection quantity with increasing engine speed, a governor main spring which is selectively adjustable by means of a speed setting member and which is operative, by way of a lever system, to oppose the centrifugal force on the flyweights and an idling spring for further opposing the centrifugal force on the flyweights after the regulating rod has been moved a specific distance, which distance is dependent upon the position of the speed setting member.

2. A centrifugal governor as claimed in claim 1, in which the speed setting member is connected by means of a spring to one end of a lever of which the other end is adapted to act on the idling spring in a sense to compress the latter as the said speed setting member is moved away from its idling position.

3. A centrifugal governor as claimed in claim 1 or claim 2, in which the governor main spring is connected between a rocking lever rotatable by said speed setting member and a reaction level of which one end is pivotably secured to a pin in the housing of the governor and of which the other end is arranged opposite a thrust sleeve movable by said flyweights.

4. A centrifugal governor as claimed in claim 3, in which said other end of the reaction lever abuts against an adjustable stop in the governor housing.

5. A governor as claimed in claim 3 or 4, in which the thrust sleeve is coupled to a guide lever which is pivotable about the same pin as the reaction lever, said guide lever being arranged to act upon an intermediate lever which is adapted to determine the position of the regulating rod of the fuel injection pump.

6. A governor as claimed in claim 5, in which the idling spring is arranged to act upon the intermediate lever after the latter has moved a distance dependent upon the position of the speed setting member.

7. A centrifugal variable speed governor of the kind described initially, constructed, arranged and adapted to operate substantially as hereinbefore particularly described with reference to and as illustrated in Figs. 1, 2 and 3 of the accompanying drawings.

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1300708 COMPLETE SPECIFICATION

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Sheet 1

Fig.1

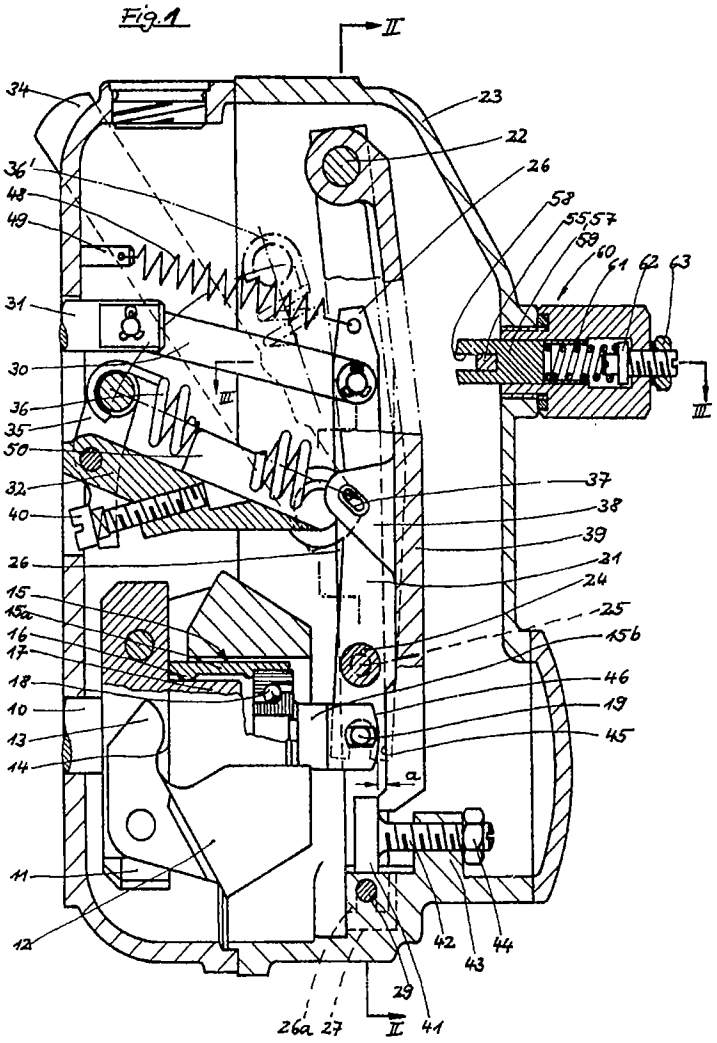
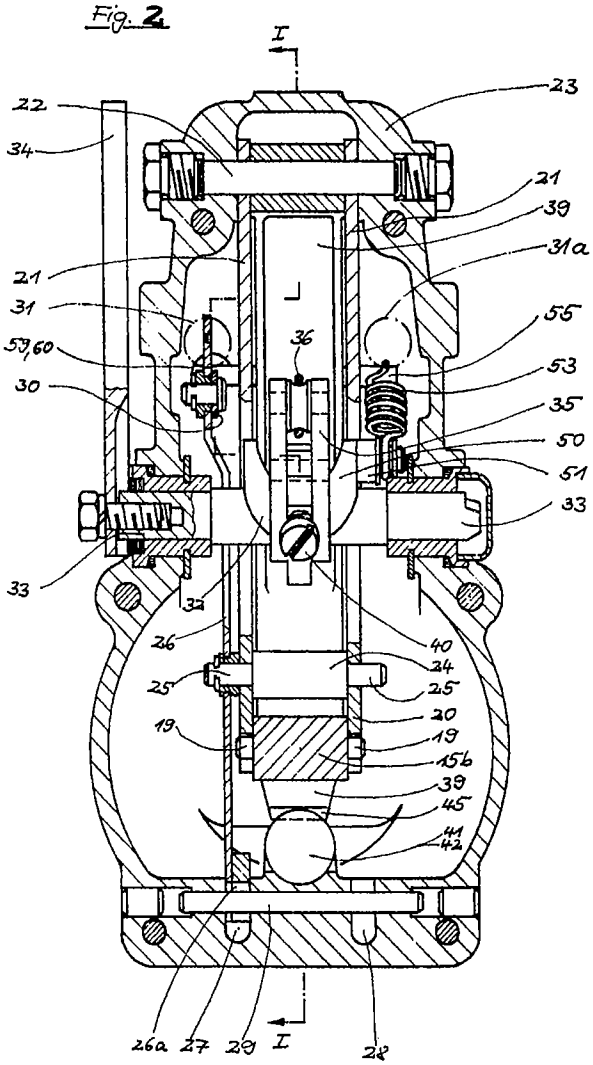


Fig. 2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1300708 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 3

Fig. 3

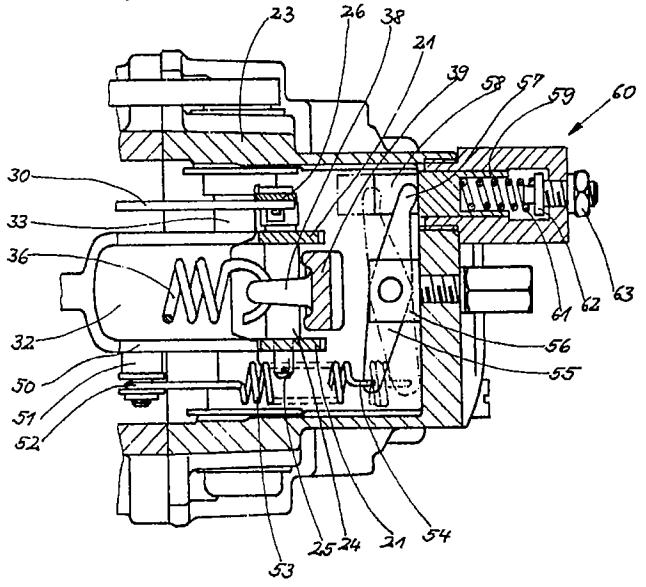

Fig. 4